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THOUGHTS ON THE TEACHING AND PRACTICE OF MEDICINE[1]

TWENTY years ago at St. Louis I pointed out the contrast between the definitions of medicine in two French dictionaries published one hundred years apart.

In a dictionary of the academy published in 1789, one may read these words: "Medicine . . . the art that teaches the method of preserving the health and healing diseases . . . (Medicine is a conjectural art)."

And one hundred years later in Littré's dictionary: "Medicine . . . the art which aims at preserving the health and healing diseases, which is based on the science of diseases or pathology."

The first definition was not quite fair, for already, in 1789, there had been for centuries those who had carefully observed and recorded and reasoned, and laid unshaken foundations for the scientific basis on which the medical art has come to rest. But the dramatic contrast between the medicine of the French revolution and the medicine of one hundred years later was hardly exaggerated.

Fifty-one years ago, in but a few weeks, the association between two great men began with this letter to Louis Pasteur:[2]

My dear Sir:

Will you allow me to offer you a pamphlet which I am sending you by the same post, which gives an account of some studies on a subject on which you have shed so much light, the theory of germs and fermentation? I like to think that you may read with some interest that which I have written on an organism that you first studied in your memoir on so-called lactic fermentation.

I know not whether the British Annals of Surgery have ever come under your observation. If you happen to have read them you have probably found, from time to time, notes on the antiseptic system which I have been putting to the test during these last nine years.

Let me take this occasion to offer you my most cordial thanks for having demonstrated by your brilliant researches the truth of the theory of the germs of putrefaction, and of having thus given me the only principle which could bring an antiseptic system to a satisfactory completion.

If you should ever come to Edinburgh it will, I fancy,

[1] Remarks made on the occasion of the dedication of the Colorado State Hospital and School of Medicine on January 23, 1925.

[2] This is translated from Valléry-Radot's "Life of Pasteur." I know not whether the original was in French or English.—W. S. T.

be a real pleasure for you to see at our hospital in what large measure the human race has profited by your work. Need I add what great satisfaction I should feel in showing you here that which surgery owes to you?

Excuse the informality which springs from our common love of science, and believe in the deep regards of

your sincere

Joseph Lister

This was scarcely fifty years ago. Pasteur was striving, with but mediocre success, to impress on his surgical friends the necessity of antiseptic precautions. Think again of the progress of the art of medicine in its broadest sense and of its scientific foundations in these fifty years!

'Twas but yesterday—forty years ago—that I entered the school of medicine. It is interesting to recall the difference between the study of medicine in 1885 and to-day.

Forty years ago there were, connected with the few best medical schools in the country, good laboratories for the study of two of the fundamental medical sciences—anatomy and physiology. Pathological anatomy, although in Europe studied as a science, was, in most American schools, still taught by practitioners. The science of bacteriology was in its infancy.

In the medical wards of the hospital, instruments of precision were limited mainly to the thermometer and the stethoscope. The ophthalmoscope, the laryngoscope, the otoscope, were rarely used other than by the specialist. Endoscopy in all its forms was practically unknown.

The laboratory for the entire medical and surgical service when I began my hospital interneship, consisted of a room about fifteen feet long by six feet wide, including the hood, with one window. It was used for simple clinical examinations of the urine and an occasional blood count.

He who began the study of medicine too often entered the school with no knowledge whatever of chemistry; and the instruction was restricted to a few months' course in qualitative analysis, a few months' training in the examination of the urine and a few lectures on the theory of organic chemistry. It was only in the laboratories of the departments of physiology, anatomy and pathological anatomy that the student might have been lured toward a purely scientific career.

Consider the growth of the scientific foundations of medicine since that day—the growth of our knowledge of bacteriology and the relation of infection to the diseases of man and animals, of serology—the increase in our knowledge of physics and chemistry and their application to all manner of anatomical and physiological problems, normal and pathological, to pharmacology, to bacteriology, to serology, to diagnosis—the aid brought to the medical art through the introduction of such physical methods of investigation and of treatment as have sprung from the applications of galvanometry and roentgenology.

Those winged forty years have seen the entry into medicine of many methods of precision, accurate quantitative chemical and physical procedures, and alongside of the laboratories of pure science in the university, laboratories of applied science have found their way into hospital clinic and, indeed, into the doctor's consulting room.

All this has greatly strengthened the arm of the physician. It has taught him the cause and methods of prevention and sometimes of arrest of many of the gravest scourges of mankind; it has explained the nature and pointed to the means of prevention of previously baffling manifestations of disease; it is revealing daily new problems which must be solved. It has greatly strengthened the arm of the doctor, but it has placed upon him heavier and heavier responsibilities.

It is far beyond the power of one human being to master the whole domain of medicine. In the university, in the hospital, in practice, individuals *must* of necessity limit their activities more and more to special provinces of the science or the art. And more and more is division of responsibility and cooperation necessary in medicine as in other spheres of life.

Along with the advances in our knowledge of the natural sciences there have appeared in the world of industry those amazing mechanical devices which have resulted in an increasing delegation of responsibility and division of labor. By the use of complicated machines and by the cooperation of a relatively small number of individuals, each devoting himself to one little division of the work, the finished automobile is constructed in an incredibly short period of time and at a remarkably small expense. That automobile answers its purpose; it has been a boon to mankind. So it is in all branches of industry. The world is flooded with machine-made products which answer their purposes. Labor-saving machines have, in a sense, transformed the industries. Where, in the past, at a considerable expense, an article made by careful individual workmanship, an article that lasted a lifetime, could be obtained by the few, now the many may, at a minimal cost, obtain a like product made by machinery, inferior, to be sure, and lasting but a year or two, but answering its purpose—a blessing in its way to the world at large, but not an unmixed blessing. For society is becoming standardized in its use of inferior products; so accustomed to them and so well satisfied with them that the distinctions between the real and the shoddy are barely appreciated by the many.

Modern industry in great part strives to produce in mass that which will answer its purpose; that which "will do." Scientific progress in the industries has brought labor-saving devices, division of labor and mass production; but the skilled mechanic and his lasting creations are vanishing.

In medicine it is different. The increase of knowledge has of necessity brought with it specialism. In the thorough investigation of a given case, the conscientious physician must often consult colleagues specially competent in special branches. The multiplication of instruments of precision and of accurate quantitative methods in medicine have increased the doctor's opportunities, but they have also increased his duties and responsibilities.

There is no short cut, there are no labor-saving devices in medicine.

It can not be denied, however, that there prevails to a certain extent in and out of the medical profession an odd *mis*conception that the laboratory has supplied us with something absolute which does away with the necessity for careful clinical study.

The patient treasures as a talisman huge sheets setting forth in figures the results of examinations which are beyond his powers of comprehension—figures which, alas, evoke sometimes disastrous mental conceptions. The doctor, as in one instance which I remember, is quite satisfied that his patient has typhoid fever because of a report from the City Health Department that the Widal reaction is positive, despite the evidences of a bacterial endocarditis which stare him in the face.

What a familiar phenomenon it is! And how grave sometimes!

There is nothing absolute in medicine. The human element enters into it at every turn.

We doctors are human beings.

Our patients are human beings.

Our instruments are devised and made and used by human beings.

The results of our tests are read and interpreted by human beings.

Fallibility is human!

The doctor himself must watch and weigh every incident in the course of the disease. He must know when he needs assistance and from whom to seek it.

Figures and words—How we human beings love them!

Figures and words suggest the absolute. The "diagnostic clinic," for instance—wonderful words!

Of what value to the thoughtful physician are volumes of special and laboratory reports if he knows not who made them and the conditions under which they were made?

The growth of those absurdly miscalled "diagnostic clinics" with too widely delegated responsibility is a sad evidence of our thoughtless subjection to the greatest of human tyrannies—the tyranny of words. The difference between the diagnostic opinion of one wise man who may be counted upon not only to give of his own knowledge and experience but to seek that of others when it is needed—the difference between the diagnostic opinion of one wise man and the sheets setting forth a so-called "survey" from the average "diagnostic clinic" or the advertising institute is the difference between light and darkness.

A machine-made diagnosis is a shoddy product; it does not wear well and it rips on the first strain. More than this, it is dangerous; it will not do.

Where forty years ago the questioning, the examination, the observation, the study that enabled a conscientious physician to give his patient his best advice was often a relatively simple matter, to-day it may be a long and laborious problem, time-taking and expensive.

The multiplication of scientific methods of investigation has not transformed; it has broadened the art of medicine. In so doing, it has not diminished; it has increased the duties and the responsibilities of the practitioner, who, to-day, must have a much better general and special education than forty years ago.

To-day the practitioner must, as ever, have a sufficient knowledge of the strictly fundamental medical sciences—biology, anatomy, physiology, bacteriology, serology, pharmacology. But to understand these and appreciate the significance of, if not actually to carry out himself, a large number of diagnostic and therapeutic procedures, he must have no inconsiderable knowledge of mathematics, of modern physics and chemistry, inorganic, organic, physical.

And that which should never be forgotten, but sometimes is forgotten—*this larger scientific basis saves not one hour of the necessary training and experience in the art of physical diagnosis and in the study of disease at the bedside, of that sympathetic contact with suffering men and women through which alone efficiency in the art of medicine can be attained.*

Not all the chemistry and physics in the world can make a good diagnostician or a good practitioner or a good teacher of him who is not at home by the bedside.

One of the greatest defects in the teaching of medicine in America to-day is the lack of sufficient training in habits of accurate clinical observation and description and in the art of physical diagnosis. It is often exemplified by the surprise of the student at the evidences of the acuteness of the observation of the better students of a hundred years ago. Sometimes I wonder if our carelessness in this most vital part of

the training of the doctor is not perhaps a part of a general tendency of the times, a tendency to delegate responsibility, to accept anything that "will do," material, intellectual or moral; to be satisfied with quantity rather than quality; too great a readiness to accept, thoughtlessly, the easier way, as for instance, is exemplified by the rather simple performances of some who practice the so-called "simplified spelling." It is, by the way, hardly conceivable that that man could be capable of discriminating clinical observation who would substitute "thru" for "through."

But to return to our main theme. As the duties and responsibilities and opportunities of the physician and the surgeon have increased, so, also, has the scope of the university school of medicine and the university hospital broadened.

The hospital is the heart of the school of medicine. The first and fundamental function of any hospital is the care of the sick. For this the university hospital should be peculiarly well prepared.

The care of the sick should be carried out best by men who have the best fundamental knowledge of the medical sciences, combined with experience in the art of practice—who have at their disposal adequate means for the thorough observation, study, investigation and treatment of their patients. "Adequate means" signifies to-day a rather elaborate equipment in the way of instruments of precision and of laboratories in which the examinations and studies necessary for the routine conduct of the clinic may be made, and in which special investigations may be carried out under special circumstances. These laboratories will and should vary in various clinics. The simplest form is the single clinical laboratory with a suitable personnel capable of carrying out those routine examinations of excreta, secreta and body fluids which may not be done in the wards. In many university clinics there will arise in connection with the medical service special chemical, bacteriological and serological laboratories which are really laboratories of applied science. These will be presided over by men who, while yet taking part in the clinical activities of the department, are especially interested and qualified students of one special branch of medicine, chemical, biological, physical, as the case may be. Such students and teachers demand adequate salaries, for in their positions they will and do devote many years of their lives to scientific studies in ward and laboratory, to the great advantage of the hospital and the school.

The laboratories associated with one good medical clinic will doubtless differ somewhat in number and character from those of another. It is well that this should be so. According to the special competence of individuals, and subject to special conditions which may exist in a given clinic, special laboratories and divisions of the medical service may rise for the temporary or continued study of special problems—tuberculosis, syphilis, cardiac disease, for instance.

Then the professor of medicine must have an adequate number of junior assistants to help in the study and observation and care of his patients, in recording their progress and especially in making routine minor laboratory examinations. Outside of the regular hospital interne, this desideratum is very difficult to fill fully in other than a university hospital. Here, however, it is filled as nowhere else, by advanced students. These men supply a body of unequalled junior assistants, such as can be obtained in no other way. The employment of the advanced student as a ward assistant, a clinical clerk, as they say in England, has brought the greatest single improvement in our ability properly to care for the sick that has been introduced in this country in my lifetime. I have known wards with and without student assistants; I have known wards in term and out of term time; and I know full well how much better are the chances for recovery of the patients in a ward with student assistants than in a ward attended by the interne alone. When I am ill let me be cared for where there are student assistants!

The second function of the university hospital which is really coordinate with the first—the care of the sick—is the teaching of medicine. The requisites for the two functions are essentially the same. The best teacher is almost always the wisest physician. The wisest physician is always a student. And in order to obtain his services as a teacher, the university must offer him opportunities to continue his studies as well as opportunities for the observation and care of the sick. This means a suitable equipment in the way of instruments of precision, laboratories and associates to preside over these laboratories, with adequate salaries to support the group of senior associates and assistants who will preside over special divisions of the service and special laboratories of applied science and for many years may give their time largely or entirely to hospital practice and teaching and research.

Of primary importance is it that the professor of medicine should have under his control clinical material sufficient to allow him to utilize his full staff. The professor himself can do but a small part of the necessary teaching. The same will be true of the senior associates in charge of the special divisions of his service. The professor must be afforded opportunities to associate with his clinic the necessary group of clinicians. His department must be a clinical center toward which physicians and patients

in the community turn for special advice. Associated with the department of medicine of the university must be clinical professors who are the recognized leaders in their art.

This is vital for the student, for from the example of the experienced clinician he can best acquire proficiency in the art of medicine.

It is vital for the senior associates who must be relieved from unnecessarily arduous clinical duties and should be afforded opportunities to gain themselves that clinical experience and competence which they will ultimately need.

It is vital for the clinic itself, because if the department of medicine of the university be not the recognized clinical center of the community, it will be unable to command the personnel that it should have; it will be unable to do its full duty to patient, to student or to the community; and it will be in grave danger of falling into isolation and mediocrity.

The third great function of the university clinic is that of research. Research means study, analytical and experimental, in ward, in laboratory, in consulting room. A clinic that is properly equipped for the care of its patients and for teaching will be properly equipped for research. The qualified teacher in any branch of medicine is of necessity a student. There is no place in the medical school of to-day for the mere vulgarizer of knowledge. What we try to do to-day is not to feed the student with assertions but to teach him how to teach himself. We seek to teach him methods and encourage him rather to doubt and to prove for himself the truth or error of the assertions of others.

The modern school of medicine and the modern hospital should make it possible for the members of the staff to pursue research, to study their problems more thoroughly by increasing their freedom in every possible way, through adequacy of salary and through affording opportunities in hospitals and laboratories for post-graduate study in the shape of fellowships and voluntary assistantships which enable the chief to contribute to the advances of the medical science and art through the active work of the increasingly large body of young men who are every day seeking the opportunity to give their time to the elucidation of special problems under the advice and direction of a master.

It is, I believe, greatly to the advantage of hospital and university that special opportunities be afforded the head of a department and his chief associates for holding such consultations as they may desire to hold *at the clinic*. This is time saving; it centralizes the work of the teachers at the point of their main activities, and it brings to the clinic an invaluable stream of selected cases of special interest —special problems referred to them by their colleagues from near and far.

Much of such material may not be directly utilizable for teaching purposes before the general student body, but it is invaluable for the staff, especially those members of the staff who are studying special problems.

Every effort should be made to free the chief of a service from unnecessary responsibility or anxiety, for the multiplicity of duties falling on the shoulders of the director of a large department of medicine to-day have come to be a rather heavy load.

The recognition that such men must be adequately salaried is a great step forward.[3] But beyond this the question as to how to deliver the director from the whirlpool of administrative duties is puzzling and serious.

I have said enough. There is no fixed model; no one way by which alone medicine can be or should be taught. I have given you a few of the thoughts which have arisen from my own experience. You have the opportunity, under exceptionally favorable circumstances, of solving the problems in your own way.

The sight of these beautiful buildings, the conversation with those privileged friends who have the chance to show to the world what they can do with the opportunities that lie before them, remind me of the days nearly thirty-five years ago now, when I came to Baltimore, but a year after the opening of the Johns Hopkins Hospital. In those days I was but an insignificant member of the fortunate group of men who had the joy, free and unfettered, of shaping the destinies of that institution.

May you be as free! May your happiness in your work be as great! May your accomplishments be greater!

W. S. THAYER

BALTIMORE

A SYSTEM OF "DEFINITIVE UNITS" PROPOSED FOR UNIVERSAL USE[1]

ABSTRACT: It is proposed that physicists discard the CGS and Heaviside units, which are responsible for much confusion and needless mental effort, and

[3] The effort to put the medical school and medical teaching more and more on an university basis, that is being made in many of our better medical schools, is not a revolution in methods; it is an evolution springing directly from ideals which have always guided the wisest students and teachers and practitioners.

[1] Read at the International Mathematical Congress, at Toronto, August, 1924.

employ exclusively a single system of "definitive units." The units suggested include the international meter, the international kilogram, the second, the mechanical watt, the international mercury ohm and they conform with the other international units as closely as is compatible with self-consistency. The system is not only definite and absolute, but also comprehensive, readily visualized and, in large part, already employed under well-established names. The system was proposed in 1901 by Giorgi and in 1904 by Robertson but received scant attention on account of the artificial prestige of the CGS system. A single universal system of units should be the ultimate goal, and the "definitive units" are chosen with a view to their adoption not only by all scientists but also by the butcher, the baker and the candlestick-maker.

THE PROBLEM OF UNIVERSAL UNITS

The purpose of this paper is to advocate the use of a single system of units meeting these two essential requirements:

(1) Universal applicability for all purposes from the common every day practical needs to the most exacting scientific uses.

(2) Ready transition to the single system involving minimum change and inconvenience.

It is unnecessary here to stress the importance of a common meeting ground for all commercial countries in the matter of units. The existing confusion and waste due to the multiple, redundant units which are still in use is quite generally recognized, and progress is being made towards universal units. It is most important that a proposed universal system of units should not call for radical changes; otherwise, its chance of securing adoption is small. For the proposed system what has been done has been to choose from among the multiplicity of existing units the ones best adapted to form a single, comprehensive and final system for universal use. These units are shown by Table I in the column headed "Definitive Unit"; each unit, with the exception of the (10^5dyne) unit for force, is now in common use. Furthermore, the international prototype meter and kilogram became the fundamental standards of length and mass in the United States in 1893, while eight of the remaining units (or their international electrical equivalents) were legally established by law in 1894. It is believed that the proposed "definitive" system may be advantageously adopted by individuals, and without inconvenience, even in the absence of further legislative or other general adoption.

Even though we recognize the difficulties in the way of securing the universal adoption of any one system of units, it is nevertheless extremely worth while to determine the best system of units for this purpose, and to secure for it the widest possible adoption as rapidly as possible. It is especially important that physicists should show the way by exclusively employing the system adapted for universal use, before custom and legislation have established additional units which can not be absorbed into such a system. This change will directly benefit physicists themselves, for they are now handicapped by the intermingled and varying use of many systems of units, including the CGS electrostatic, the CGS electromagnetic, the practical, the international, the rational, the ampere-turn and the gravitational systems in addition to the metric system. Upon the first four of these systems the British Association Committee on Electrical Standards placed the seal of its approval without, apparently, any serious consideration of the possibility and desirability of a single universal system. The CGS system has served a great purpose. It was a long step towards complete unification, but it was not intended to be and is not adapted to be the single universal system and for that reason it should give place to a truly universal system as soon as possible.

It is important that the subject of units should now be considered from a comprehensive, universal point of view because of possible legislation extending the use of the metric system. Fortunately scientists are in a position, on the basis of a long and essentially successful experience with metric, absolute CGS and other units, to specify the complete system of units which may be confidently fixed as the universal goal. All changes which are introduced should be consistent with and aid in bringing about the ultimate adoption of a universal system of units. Proposals looking toward the adoption of the metric system in the United States and elsewhere should consider the question of units broadly and not merely adopt the meter-liter-gram units because these were the original metric units. As shown by Table I, the kilogram is required for consistent interrelation with the meter, second and watt. Furthermore, the consistent unit of volume is the stere or meter cube, which is almost exactly a kiloliter.

It is important that the proposed universal system of units bear a simple, distinctive name, especially since many of the individual units brought together in the system differ little, if at all, from units which are already associated with one or more existing systems of units. The name proposed is "definitive," and this name is appropriate because these units are the best final selection from among all metric possibilities. Justification for the name does not require proof of absolute finality; it is recognized that with the advance of science some new basis for units superior to the metric basis may be discovered. In that

event the definitive units should be superseded. In the meantime, however, every worker in science, engineering, industry, commerce and everyday affairs may confidently turn to the definitive system for his units.

PROPOSED DEFINITIVE UNITS

The proposed units are shown in Table I, together with the conversion factors for reducing several other systems of units to definitive units. The meter and the second are the two units for the space-time framework; the watt and the joule are the units for power and energy, the essential binding links in all physical transformations; the (10^5dyne) and the (kilogram) are the dynamical units for force and mass. The definitive system includes the international prototype meter, the international prototype kilogram, the international mercury ohm, the international farad and the international henry. The definitive watt, however, is the mechanical, not the international, watt, the latter being 340 parts in a million larger. The definitive ampere, volt and coulomb are, consequently, each smaller than the corresponding international unit by 170 parts in a million. These differences are negligible except in refined scientific work.

The definitive units are so simple and convenient that it is surprising that they were not adopted originally in place of the CGS units; as far as I know no extended use has ever been made of them as a comprehensive system. The system was proposed, however, in 1901 by Giorgi under the name of the "absolute practical" system, and in 1904 by Robertson as the "complete practical" system. The solid advantages which they pointed out were almost ignored due to conservatism and the artificial prestige of the CGS system. Emde recommended the adop-

TABLE I

FACTORS FOR CONVERSION INTO DEFINITIVE UNITS[1]

Quantity	Symbol and Definitive Unit[2]	Value of Unit in Terms of Definitive Unit[3]					
		International Unit	Practical Unit	CGS Electromagnetic Unit	CGS Electrostatic Unit	Gaussian-Heaviside-Lorentz Unit	Mechanical Metric K-M-S Gravitational Unit
Length	s Meter	1	10^7	0.01	0.01	0.01	1
Time	t Second	1	1	1	1	1	1
Power	P Watt	1.00034	1	10^{-7}	10^{-7}	10^{-7}	0.1019716^{-1}
Energy	W Joule	1.00034	1	10^{-7}	10^{-7}	10^{-7}	0.1019716^{-1}
Force	F (10^5 dyne)			10^{-5}	10^{-5}	10^{-5}	0.1019716^{-1}
Mass	M (Kilogram)	10^{-3}		10^{-3}	10^{-3}	10^{-3}	1
Resistance	R Ohm	1	1.00052^{-1}	$1.00052^{-1}\ 10^{-9}$	$1.1130^{-1}\ 10^{12}$	1.1290×10^{13}	
Current	I Ampere	1.00017	1.00026	1.00026×10	$2.9974^{-1}\ 10^{-9}$	$1.0626^{-1}\ 10^{-10}$	
Potential	V Volt	1.00017	1.00026^{-1}	$1.00026^{-1}\ 10^{-8}$	2.9974×10^2	1.0626×10^3	
Electricity	Q Coulomb	1.00017	1.00026	1.00026×10	$2.9974^{-1}\ 10^{-9}$	$1.0626^{-1}\ 10^{-10}$	
Capacity	C Farad	1	1.00052	1.00052×10^9	1.1130×10^{-12}	$1.1290^{-1}\ 10^{-13}$	
Inductance	L Henry	1	1.00052^{-1}	$1.00052^{-1}\ 10^{-9}$	$1.1130^{-1}\ 10^{12}$	1.1290×10^{13}	
Magnetomotive force	F (Amp.-turn)			1.25631^{-1}		2.82168	
Magnetic flux	ø (Weber)			$1.00026^{-1}\ 10^{-8}$		$2.82168^{-1}\ 10^{-7}$	
Magnetic pole	m (Weber)			1.25631×10^{-7}		$2.82168^{-1}\ 10^{-7}$	
Reluctance	R (Amp.-turn/weber)			$1.25598^{-1}\ 10^8$		$1.25598^{-1}\ 10^8$	

[1] A numerical magnitude based upon any unit is transformed to the corresponding definitive unit by multiplying by the tabulated value of the original unit. A literal relation, $f(A, B, C \ldots) = 0$, transformed to $f(A/a, B/b, C/c \ldots) = 0$, holds for definitive units, a, b, c being the tabulated values of the original units for A, B, C respectively.

[2] The definitive units are connected by the ten, simple, fundamental energy relations:

$$W = Pt = Fs = \frac{1}{2}Ms^2 = RI^2t = VIt = \frac{1}{2}CV^2 = \frac{1}{2}QV = \frac{1}{2}LI^2 = \frac{1}{2}F\phi = \frac{1}{2}R\phi^2.$$

[3] Based upon the experimental constants: velocity of light = $v = 299.82 \times 10^6$ meter/sec.; acceleration due to gravity = $g = 9.80665 = 0.1019716^{-1}$ meter/sec.^{2}; international ohm = $r = 1.00052$ "practical" ohm; international ampere = $a = 0.99991$ "practical" ampere. Therefore, $a^2r = 1.00034 = 1.00017^2$; $v^2r^{-1} = 1.1130^{-1}\ 10^{-17} = 2.9974^2\ 10^{16}$; $4\pi v^2 r^{-1} = 1.1290 \times 10^{18} = 1.0626^2 \times 10^{18}$; $r/4\pi = 12.5598^{-1} = 0.282168^2$; $4\pi r^{-\frac{1}{2}} = 12.5631$; $r = 1.00026^2$, from which follow the tabulated values.

tion of Giorgi's proposal but only as a temporary transition system. The absolute CGS units have continued to be regarded as the fundamental, complete system of units; to be extensively supplemented in practice, nevertheless, by the intermingled use of metric, practical, rational, international and ampere-turn units. No uniformity of practice has prevailed, the units from different systems being combined by different authors in different ways.

A consistent system employed to a very limited extent in electrical engineering satisfies the connecting relations of the definitive units but makes use of the centimeter-(10^7dyne)-(10^4kilogram) in place of the meter-(10^5dyne)-(kilogram). For a universal system, however, the meter is to be preferred to the centimeter and the kilogram to the (10^4kilogram). The meter and the kilogram are the units now in actual use in commerce and practical life in metric countries; the centimeter is recognized as a basic unit by scientists but not to the extent of influencing the nomenclature; 10,000 kilograms as an everyday unit of mass is much too large since it lies far beyond ordinary sense experience. No other possible combination of metric multiples is to be preferred, but it may be noted that the combination of the dekameter-(10^4dyne)-(10 gram) has the attractive feature of making weight and mass numerically equal to each other within 2 per cent.

Advantages of Definitive Units

The proposed definitive units combine, to a remarkable degree, the best features of all existing systems of units. The following may be specially noted:

1. Definitive units are independent of place and time. They are absolute in this and every other respect and the peers of the CGS unit for the most refined scientific work.
2. Readily visualized magnitudes of convenient size for everyday needs characterize the definitive units of the more important quantities. The meter and kilogram are the common metric units of length and mass. The definitive unit of force (10^5dyne), which is approximately the force of gravity on 0.1 kilogram, is a force which is directly apprehended, whereas the dyne, the CGS unit, corresponds more nearly to the proverbially negligible weight of a feather.
3. Convenient names are already in common international use for most definitive units or their practical equivalents. Eventually a few new names should be adopted so that no basic definitive unit will be encumbered with a numerical prefix as in (10^5dyne), (kilogram) and (centare). Names are quite secondary to the adoption of the universal system. Apparently the adoption of definitive units would be hindered rather than helped by the simultaneous consideration of new names for units, if we are to judge by the discussion elicited by Giorgi and Robertson twenty years ago.

TABLE II

Physical Constants in Terms of Definitive Units

	Numeric	*Unit*
Radius of positive electron	1 micro^3	meter
Diameter of negative electron	3.8 micro$^{2.5}$	"
Wave length shortest γ-ray	5.7 micro^2	"
Wave length cadmium red No. 1	643.84696 micro$^{1.5}$	"
Earth to sun	0.1495 mega^2	"
Light year	9.4614 mega$^{2.5}$	"
Parsec	30.838 mega$^{2.5}$	"
Radius curvature of space (Silberstein)	1 mega^4	"
Mean solar year	31.556926 mega	second
Velocity of light in free space	299.82 mega	(m./sec.)
Capacity of meter cube of free space	8.8572 micro^2	farad
Inductance of meter cube of free space	1.25598 micro	henry
Iterative impedance of free space	376.57	ohm
Resistance of one kilogram of mercury in a column one meter long	12.7898 milli	"
Force betwen two kilogram point masses separated one meter	66.58 micro^2	(10^5 dyne)
Force between two coulomb point charges separated one meter	8.9845 mega$^{1.5}$	"
Force between two weber point poles separated one meter	63.359 kilo	"
Charge of negative electron	0.1593 micro^3	coulomb
Mass of negative electron	0.89 micro^5	kilogram
Mass of sun	2.0 mega^5	"

4. A complete, coherent system of definitive units is obtained by so extending Table I as to avoid useless coefficients, in essentially the same way as for CGS units. The complete table would include units for area (centare), volume (stere = 1.000027^{-1} kiloliter), velocity (meter/second), electric force (volt/meter), temperature, entropy, etc.
5. The entire range of each quantity encountered throughout all nature is conveniently referred to the single corresponding definitive unit by the use of numerical prefixes. These prefixes are to be regarded as a part of the numeric and not as creating an independent basic unit. Arithmetical notation supplies different methods of expressing these prefixes, and further developments are doubtless possible. Table II illustrates the use of powers of mega and micro prefixes to cover the entire range of nature in categories of a million; the known range of lengths extends over only seven of these categories. As far as I have looked into the matter twelve of these categories suffice for any one of the quantities of physics, as known to-day.
6. The minimum changes in commerce, in legislation and in scientific instruments are called for by

definitive units since the largest possible number of international units are retained.

7. Conversion of existing results into definitive units is made simple by the use of Table I. The table may be extended so as to include English units and the algebraical as well as the arithmetical relations between units. A grounding in the definitive units is sufficient for every one; familiarity with the CGS units or with the historical rôle which they played as progenitors of definitive units is not essential. Results expressed in the older units are readily reduced to definitive units by the mechanical use of the table.
8. Definitive units do not artificially exalt any four units as being preeminently the basic primary units for all purposes. Any choice may be made which will simplify a particular problem under discussion. Among the first twelve units of Table I, four dimensionally independent units may be chosen in 299 different ways.
9. The ten fundamental relations of Table I, Footnote 2, hold also for Heaviside's units. Since the only present use for Heaviside's units is to obtain these relations and others based upon them, his specific units may be abolished, thereby materially simplifying the connection between theoretical electromagnetism and practical measurements.
10. Complete, homogeneous, physical equations (which are best adapted for theoretical physics) are naturally employed with definitive units, since no dimensional constant of nature has by advance agreement any specific numerical value such as unity or 4π. Some of the more important dimensional constants, expressed in definitive units, are included in Table II. The choice of units need introduce no changes in the use of convenient ratios, such as permeability and dielectric constant.

CONCLUSIONS

The definitive system of units makes it perfectly feasible to employ a single system much more generally than has ever been the case in the past; the natural ultimate goal is the universal use of these units for all purposes. In the attempt to extend the application of metric units in the United States the meter-stere-kilogram, rather than the meter-liter-gram, should form the basis for legislation, in order to give definitive units their proper legalized status and to secure to the full the advantages of a comprehensive system consistently interrelated with the legalized international electrical units. The gradual discarding of CGS and other redundant units would inevitably follow. Even in the absence of official recognition of definitive units, individuals may advantageously employ the system. This would cause confusion neither to authors nor readers, since these units, in the main, have already acquired vital existence through world-wide, daily use under familiar, well-established names.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ASSOCIATED ORGANIZATIONS

A VERY large proportion of the American organizations devoted to the advancement of the sciences and of science in general are officially associated with the American Association for the Advancement of Science (see SCIENCE for February 6, page 166). This feature of the organization of the association is very important and it is continually becoming more so. For the general cooperation of American men and women of science and of American friends of scientific advance the association furnishes convenient arrangements, which are being continually improved, and this is also and specially true with respect to the cooperation of the many special scientific societies of America, in the work of emphasizing the broad unity of science in general and furthering its advancement and its appreciation by the public.

It will be recalled that associated organizations are of two kinds, those that are simply *associated* and those that are *associated* and *affiliated*. Simply associated societies have the general official approval of the association and the latter aids their work wherever possible. Affiliated societies have the same relation to the association and they also have representation in the association council and generally in the respective section committees, thus being in a way constituent units in the larger organization. Furthermore, members of each affiliated society who are not already enrolled in the association have the privilege of becoming so enrolled without paying the usual five-dollar entrance fee, if they join before the second October 1st following the affiliation of the society or before the second October 1st following their election to the society. Official association and affiliation are arranged by application to and election by the association council. No financial or other serious obligations are attached to the arrangements of association and of affiliation but affiliated organizations are generally expected to supply the association annually with lists of their new members, whom the association invites to join it under the special conditions just mentioned. A list of all associated organizations, of both kinds, is published

by the association from time to time. Affiliated societies are generally the larger ones and those that deal with scientific research, while smaller societies and those not dealing mainly with research, but nevertheless operating for the advancement of science, are generally simply associated. Societies sometimes become associated first and are subsequently elected to affiliation. The association depends on the scientific societies to make application for official association or combined association and affiliation and each application should generally be accompanied by a copy of the society constitution and a list of its members. Affiliated societies each have one representative in the association council and they have an additional representative if their membership includes one hundred or more fellows of the association.

There are a few American scientific societies that, although obviously eligible to official association in the American Association, have not as yet become so, and there are a few associated societies that surely should be affiliated but have not yet made application. For readers who are interested in seeing all high-grade and extensive American scientific organizations united in this somewhat loose but truly effective way through the American Association, this brief statement has been prepared. It would have been included in the special American Association issue of SCIENCE for February 6 had there been available space.

It should be clearly and distinctly stated that official association of either sort does not imply any chance for loss of autonomy on the part of the associated organizations. As a large society of individual members, the American Association virtually surrenders its own autonomy to some degree by admitting the affiliated societies to participation in its control, but there is absolutely no corresponding tendency in the other direction. The associated organizations are asked to cooperate for the advancement of science as a whole but they clearly can not be bound by any action of the larger association. It is not expected that all associated societies should meet with the larger organization at its annual conventions in convocation week, but the association undertakes to care as well as possible for all scientific organizations that desire to meet with it on those occasions. Some of the societies generally meet with the association, some occasionally do so and some never do so. This applies to both classes of associated societies.

In the same general connection, the well-known relation of the programs of the association sections to those of the societies meeting with them may need clear statement from time to time. No section is allowed to arrange a program for the annual meeting that will in any way rival or compete with the programs of any of the societies of that section which are holding their meetings simultaneously with it and at the same place. It is expected that each section program will adequately represent the broader and more general aspects of its field of science, in a manner that is calculated to be of use to all members of all the societies belonging with the section. Section programs are generally joint programs with the societies, and they are generally of invited papers. When the societies of a section do not meet with it the section is expected to arrange a more extensive program, but in those cases also the section programs are generally confined to invited papers. In short, the desideratum should be that each field of science is to be well represented by sessions at each annual meeting, those sessions being mainly in the hands of the societies when they are present. The section is to do only those things for the advancement of science that are not done by its societies. There must be no rivalry between section and society.

The general program of the annual meeting is published by the association and it includes complete programs of all the societies meeting with it, as far as possible. If a society program is not properly presented in the general program the reason is only that the needed manuscript was not received by the permanent secretary's office early enough to be included. By relying on the general program the societies may in many cases avoid the trouble and expense of publishing separate programs, but separate society programs are apparently generally desired, even though their material is included in the larger book of the general program.

All the privileges of the annual meetings are now made free, not only to association members but also to all members of the associated and guest societies, whether these members are enrolled in the association or not.

The complete list of the associated organizations arranged according to the corresponding sections of the association follows, as it stood March 1, 1925:

*The American Meteorological Society.
**The American Physical Society.
The Honor Society of Phi Kappa Phi.

A. MATHEMATICS

**The American Mathematical Society.
**The Mathematical Association of America.

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* Affiliated societies are designated by asterisks; a single asterisk denotes one representative in the Council, two asterisks denote two representatives. For the names of the representatives, see the list of Council members, page 132.

B. PHYSICS

**The American Physical Society.
*The American Meteorological Society.
**The Optical Society of America.

C. CHEMISTRY

**The American Chemical Society.
The American Institute of Chemical Engineers.
**The American Electrochemical Society.

D. ASTRONOMY

**The American Astronomical Society.

E. GEOLOGY AND GEOGRAPHY

**The Geological Society of America.
The Paleontological Society of America.
**The Association of American Geographers.
**The Seismological Society of America.
**The American Geographical Society.
The National Council of Geography Teachers.
The American Alpine Club.
*The Mineralogical Society of America.

F. ZOOLOGICAL SCIENCES

**The American Society of Zoologists.
**The Entomological Society of America.
**The American Association of Economic Entomologists.
**The Eugenics Research Association.
**The American Society of Mammalogists.
The Wilson Ornithological Club.

G. BOTANICAL SCIENCES

**The Botanical Society of America.
**The American Phytopathological Society.
*The American Society of Plant Physiologists.
The Botanists of the Central States.
The American Fern Society.
The Sullivant Moss Society.

F-G. ZOOLOGY AND BOTANY

**The American Society of Naturalists.
**The Ecological Society of America.
**The American Genetic Association.
**The American Microscopical Society.
The American Nature-Study Society.

H. ANTHROPOLOGY

**The American Anthropological Association.
The Archeological Institute of America.
The American Folk-Lore Society.

I. PSYCHOLOGY

**The American Psychological Association.
The Southern Society for Philosophy and Psychology.

K. SOCIAL AND ECONOMIC SCIENCES

The American Civic Association.
The American Economic Association.
The Metric Association.
The American Sociological Society.
The American Statistical Association.

M. ENGINEERING

**The American Society of Mechanical Engineers.
**The American Institute of Electrical Engineers.
**The American Institute of Mining and Metallurgical Engineers.
**The American Society of Civil Engineers.
**The Illuminating Engineering Society.
*The American Society for Testing Materials.
The American Society of Heating and Ventilating Engineers.
The American Society of Refrigerating Engineers.
*The American Ceramic Society.

N. MEDICAL SCIENCES

**The American Medical Association.
**The American Association of Anatomists.
The American Physiological Society.
**The Society of American Bacteriologists.
The American Society for Pharmacology and Experimental Therapeutics.
The American Society of Biological Chemists, Inc.
The American Society for Experimental Pathology.
**The American Public Health Association.
The Society of American Microanalysts.

O. AGRICULTURE

**The American Society of Agronomy.
*The Society of American Foresters.
*The American Society for Horticultural Science.
The American Pomological Society.
The American Association of Official Seed Analysts.
The Potato Association of America.
The American Society of Animal Production.
*Canadian Society of Technical Agriculturists.
The American Dairy Science Association.

Q. EDUCATION

**The National Education Association.
**The National Society of College Teachers of Education.
**The National Society for the Study of Education.
**The American Federation of Teachers of the Mathematical and Natural Sciences.
The American Philosophical Association.
The Phi Delta Kappa Fraternity.

SOCIETIES NOT SPECIALLY RELATED TO ANY PARTICULAR SECTION

**The Society of Sigma Xi.
**The American Association of University Professors.
**The Gamma Alpha Graduate Scientific Fraternity.
The Bibliographical Society of America.
The Gamma Sigma Delta Society.
The Honor Society of Phi Kappa Phi.

AFFILIATED ACADEMIES OF SCIENCE

(These are not classed as affiliated societies, but have a special arrangement. Each has a single representative in the Council. For the names of these representatives see the list of Council members, SCIENCE for February 6, page 132. Each affiliated academy receives a financial allowance from the Association each year, to aid in its work.)

The Illinois State Academy of Science.
The Iowa Academy of Science.
The Kansas Academy of Science.
The Kentucky Academy of Science.
The Maryland Academy of Sciences.
The Michigan Academy of Science.
The Nebraska Academy of Science.
The New Orleans Academy of Sciences.
The North Carolina Academy of Science.
The Ohio Academy of Science.
The Oklahoma Academy of Science.
The Wisconsin Academy of Sciences, Arts and Letters.

BURTON E. LIVINGSTON
Permanent Secretary

SCIENTIFIC EVENTS

EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES TO THE REVILLAGIGEDO ISLANDS

AMONG the more important activities of the California Academy of Sciences during the present year

will be a biological survey of the Revillagigedo Islands. At the request of Dr. Barton Warren Evermann, director of the museum and of the Steinhart Aquarium of the California Academy of Sciences, the secretary of the navy has detailed the United States mine-sweeper *Ortolan* for the use of the academy during the investigations.

The Revillagigedos are a group of five small islands lying off the Pacific Coast of Mexico about 850 miles south of San Diego, California, and in about 20° north latitude.

The purpose of the expedition will be to make as comprehensive and thorough a survey of each of the islands as possible in the time available. This will include a study of the fauna and flora and of their surrounding waters. It is expected that ample collections of birds, mammals, reptiles, insects, fishes, marine invertebrates, plants, etc., will be made. It is the intention of the academy to donate duplicate series of specimens to the United States National Museum, and to the Museo National de Mexico.

The *Ortolan* will be in command of Lieutenant M. M. Nelson, United States Navy. The academy's scientific staff will include the following: Dr. G. Dallas Hanna, curator of paleontology, chief of expedition; Joseph R. Slevin, assistant curator of herpetology, assistant chief; Frank Tose and John T. Wright, taxidermists representing the departments of ornithology, mammalogy and exhibits; Hartford E. Keifer, entomology; H. L. Mason, botany, and Eric Knight Jordan, paleontology and ichthyology.

In addition to these, the academy has extended, through our State Department, an invitation to the Mexican government to send two Mexican biologists to accompany the expedition as guests of the California Academy of Sciences.

The islands of the Revillagigedos group are of volcanic origin and are uninhabited. They have never been thoroughly explored. Practically all that is known of their fauna relates to the birds and the fishes. Not much is known of their flora. The origin of the fauna and flora has not been determined but they are said to possess certain Indo-Pacific elements.

The expedition will leave San Francisco about the middle of April and will return at the end of June.

The cooperation of the Navy Department with scientific institutions in expeditions such as that which the California Academy of Sciences is sending out is of great benefit to science and is receiving the hearty approval of scientific men and institutions throughout the world. The cooperation is, of course, mutually helpful, as opportunity is afforded the navy to make many observations and studies in oceanography and meteorology which will prove of distinct value both to the navy and to shipping interests.

FELLOWSHIPS IN COOPERATION WITH THE BUREAU OF MINES

GRADUATE fellowships in mining, metallurgical and chemical research are offered by prominent institutions of learning in various states, in cooperation with the Bureau of Mines of the Department of the Interior. The object in offering these fellowships is to assist in the solution of different problems being studied by the Bureau of Mines that are of special importance to the region in which these institutions are located.

These institutions offer such fellowships for the college year 1925–1926: University of Alabama, the University of Arizona, the Carnegie Institute of Technology, Pittsburgh; the University of Missouri, Rolla, Mo.; the Ohio State University, the University of Utah, the University of Washington, Seattle, and the University of Idaho.

The school of mines of the college of engineering of the University of Alabama offers five fellowships in mining and metallurgical research. The value of each fellowship is $540 per year. The problems selected for investigation relate to beneficiation of iron ores.

The Arizona Bureau of Mines, a subdivision of the college of mines and engineering of the University of Arizona, offers two fellowships yielding $660 per year.

The cooperative mining courses of the Carnegie Institute of Technology offer four fellowships in coal-mining research. Each fellowship carries a stipend of $750. Subjects suggested for investigation relate to the origin and constitution of coal, acid mine waters, efficiency in coal mining, coal-washing methods, utilization of coal, coal-mine safety, spontaneous combustion of coal and coal-mine explosions.

The school of mines and metallurgy of the University of Missouri offers four fellowships, the income of which is $800 each per annum. The subjects to be investigated are the metallurgy of zinc, refractories for the metallurgy of zinc and physical metallurgy, including the heat treatment of steel.

The engineering experiment station of the Ohio State University offers three fellowships, each with a stipend of $750 per school year. Research in the ceramic and allied fields will be undertaken by these fellows.

The University of Utah offers five fellowships, each valued at $720 per annum. The subjects to be investigated will be selected from the following list: Pulverizing ores and minerals, hydrocarbons, field investigations, flotation, development of differential methods of separating various sulphide ores, hydrometallurgy of zinc, hydrometallurgy of lead, sulphate roasting of complex sulphide ores.

The college of mines of the University of Washing-

ton offers five fellowships for research in coal and ceramics. The value of each fellowship is $720 per year.

The University of Idaho fellowships are valued at $750. Previous investigations at this institution have dealt with the treatment of various classes of gold-silver ores.

Detailed information in regard to these fellowships may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C., or from the different institutions named.

THE RESEARCH CLUB OF THE UNIVERSITY OF MICHIGAN

THE Research Club of the University of Michigan, which was founded February 15, 1900, recently celebrated its quarter-centennial anniversary by a dinner in which all former members were invited to participate. The charter members of the club were: E. D. Campbell, Henry S. Carhart, Arthur R. Cushney, George Dock, Paul C. Freer, G. Carl Huber, W. P. Lombard, J. P. McMurrich, F. C. Newcombe, F. G. Novy, A. B. Prescott, J. E. Reighard, V. M. Spalding, V. C. Vaughan, R. M. Wenley and Alexander Ziwet.

The object of the club was declared to be "to unite those members of the academic staff of the university who are actively engaged in research and to originate and support such measures as are calculated to foster and advance research in the university." The influence of the club has throughout the twenty-five years been strongly felt and it has been instrumental in securing research qualifications for appointment to and promotion within the faculties of the university.

Election to the club has been carefully guarded. The published work of candidates has been scrutinized both as to quality and quantity before recommendation for election, much as is the case for elections to national scientific or other scholarly organizations.

From the original sixteen members, the club has grown until it now numbers more than one hundred and twenty-five members, and sixty-five living ex-members. In other cities, clubs have been founded that have consciously followed the plan of the Research Club, notably the club now known as the Freer Club of Manila. A booklet which will include a history of the club during its first quarter century and other pertinent data is soon to be published.

THE AMERICAN CHEMICAL SOCIETY

THE sixty-ninth meeting of the American Chemical Society will be held at Baltimore from April 6 to 10. The general program is as follows:

MONDAY, APRIL 6

10:00 A. M.—Registration Bureau opens, Emerson Hotel.

2:30 P. M.—Council meeting.

8:00 P. M.—Council meeting continued, followed by a reception and dance for council and local section members in Banquet Hall, Emerson Hotel.

TUESDAY, APRIL 7

10:00 A. M.—Reception for the members of the society in Banquet Hall, Emerson Hotel.

11:30 A. M.—General meeting, Banquet Hall, Emerson Hotel. Address of welcome by Dr. Neil E. Gordon, chairman of the Maryland Section; Hon. Albert C. Ritchie, governor of Maryland, and Hon. Howard W. Jackson, mayor of Baltimore. Response by Dr. James F. Norris, president of the American Chemical Society.

2:30 P. M.—General Divisional Programs. Industrial—Emerson Hotel; Physical and Inorganic—Southern Hotel; Organic—Southern Hotel; Chemical Education—Engineers' Club.

8:30 P. M.—Entertainment and dance, Lyric Theater.

WEDNESDAY, APRIL 8

9:30 A. M.—Divisional and Sectional Meetings at the Johns Hopkins University.

12:30 P. M.—Luncheon, Johns Hopkins University.

2:00 P. M.—Special train for Annapolis to visit the United States Naval Academy.

8:30 P. M.—Public meeting at the Lyric Theater. Addresses by Dr. R. W. Wood on "Ultra-violet light," Dr. C. H. Viol on "Radium" and Mr. C. Francis Jenkins on "Radio photography."

THURSDAY, APRIL 9

9:30 A. M.—Divisional Meetings at the Johns Hopkins University.

1:00 P. M.—Special train for Aberdeen Proving Grounds. A military demonstration will be given for the benefit of society members. A box luncheon will be served on train.

6:00 P. M.—Group dinners.

8:20 P. M.—Theater party for members of the society, Maryland Theater.

FRIDAY, APRIL 10

9:30 A. M.—Divisional Meetings at the Johns Hopkins University.

1:00 P. M.—Luncheon at the Johns Hopkins University.

2:00 P. M.—Divisional Meetings at the Johns Hopkins University.

SCIENTIFIC NOTES AND NEWS

THE Joseph Leidy medal of the Academy of Natural Sciences of Philadelphia has been awarded to Dr. Herbert Spencer Jennings, Henry Walters professor of zoology and director of the biological laboratory of the Johns Hopkins University.

A TRACT of land, ten miles south of Crescent City, Calif., 157 acres in extent, with a stand of between eleven and twelve million board feet of giant redwoods, is to be called the Henry S. Graves Redwood Grove, in honor of the provost of Yale University and dean of the school of forestry. The purchase of the tract was made possible through the generosity of Mr. George Frederick Schwarz, of New York, with some assistance from the Save the Redwoods League.

DR. JOHN M. CLARKE, New York state geologist and director of the State Museum at Albany, has been elected vice-president of the Geologische Vereinigung.

THE Faraday Medal of the Institution of Electrical Engineers was presented to Sir J. J. Thomson at the ordinary meeting of the institution held on March 19. The presentation preceded the reading of Mr. S. Evershed's paper on "Permanent magnets in theory and practice."

THE Leeuwenhoek medal of the Amsterdam Academy of Sciences will be awarded this year to Dr. F. d'Herelle for his discovery of bacteriophagy. This medal is given to the investigator who, in the opinion of the committee, has advanced most the progress of bacteriology in the preceding ten years. The other recipients have been Ehrenberg, 1875; Cohn, 1885; Pasteur, 1895; Bejrinck, 1905, and David Bruce, 1915.

EDWARD B. CRAFT, executive vice-president of the Bell Telephone Laboratories, Inc., has been elected a director of that corporation to fill the place left vacant by the resignation of Walter S. Gifford.

THE Honorable W. G. A. Ormsby-Gore, M.P., under-secretary of state for the Colonies; Sir Frank Heath, secretary of the Department of Scientific and Industrial Research, and Sir Richard Gregory were the principal guests at the annual dinner of the National Union of Scientific Workers held at the Adelaide Gallery on March 19. The president of the union, Professor G. H. Hardy, presided.

DR. DEAN DEWITT LEWIS, of the medical school of the University of Illinois, Chicago, has been appointed surgeon-in-chief of the Johns Hopkins Hospital, to fill the place left vacant by the death of Dr. William S. Halsted.

THE senate has confirmed the appointment of Wilder S. Metcalf, of Lawrence, Kansas, as commissioner of patents. Mr. Metcalf, however, has only accepted the position temporarily to enable President Coolidge to make a recess appointment.

THE committee on scientific research of the American Medical Association has made the following grants: Harry L. Huber, Chicago, for a chemical and immunological study of pollens, $500; Dr. Arthur M. Yudkin, New Haven, for a study of experimental cataract, $500; Dr. Arthur W. Meyer, Stanford University, for a study of experimental polyneuritis, $400; Dr. Margaret M. Hoskins, University of Arkansas Medical School, Little Rock, for a study of physiological action of thyroxin, $100; Dr. Charles E. Simon, Johns Hopkins University, for an experimental study of measles, $200; Dr. William G. Lennox, Harvard Medical School, for an experimental study of epilepsy, $100.

THE Hawaiian Botanical Society recently elected officers for 1925 as follows: *President,* H. Atherton Lee; *vice-president,* Herbert F. Bergman; *secretary,* Harold L. Lyon; these three, with Dr. Frederick C. Newcombe and Dr. F. G. Krauss, constitute the executive committee of the society. The society extends a welcome to mainland botanists visiting in the Hawaiian Islands or those passing through to or from the Orient. Its members will be glad to be of assistance.

DR. ROBERT CHAMBERS, JR., professor of microscopic anatomy, Cornell University Medical College, has been invited by several British universities to deliver a series of lectures on the nature of living protoplasm as studied by his microdissection and injection methods. Dr. Chambers sailed for England on March 28, to visit King's College and University College, London, the Universities of Liverpool, Oxford, Cambridge and St. Andrews.

THE German Society for Cancer Research has elected Dr. Frederick L. Hoffman, consulting statistician of the Prudential Insurance Company, an honorary corresponding member. Dr. Hoffman is at present engaged in directing the Cancer Survey of San Francisco, which for control purposes includes a number of other cities, particularly Boston, New Orleans, Chicago, Buffalo and Albany.

DR. WILLIAM H. WESTON, JR., assistant professor of botany at Harvard University, has been granted leave of absence for the second half of the current academic year, to continue in Cuba some phases of the study and control of the sugar cane mosaic disease.

La Revue Scientifique of Paris, in its number of December 27, 1924, under the title "L'évolution des rapports internationaux—(*Discours de M. L. O. Howard, Président, á l'ouverture du 1er Congrès Pan-Pacifique de la Conservation des Aliments s'étant tenu à Honolulu (Hawaii) en juillet 1924*)," publishes a full translation into French of Dr. Howard's address which was printed in SCIENCE for September 19, 1924.

BY invitation of the Association of American Petroleum Geologists, the Kansas Geological Survey and the Geological Society of Kansas, the public address

on the occasion of the annual meeting of the association at Wichita, Kans., which was held on March 26, 27 and 28, was given by Dr. John M. Clarke, of the New York State Museum at Albany.

ON March 20 and 21, Professor F. R. Moulton, of the University of Chicago, gave lectures in Jackson, Miss., before the Southern Section of the Mathematical Association of America, on "Recent astronomical discoveries" and on "Ballistics." Professor Moulton gave the same lectures at Tulane University, New Orleans, on March 23, one before the New Orleans Academy of Sciences and the other before the Mathematics Club of Tulane University.

PROFESSOR H. K. HAYES, of the department of plant breeding of the University of Minnesota, addressed the Sigma Xi Club of Carleton College on March 10 on "The relation of genetics to plant breeding."

THE Fison Memorial Lectures, established in memory of the late Dr. A. H. Fison, lecturer in physics at Guy's Hospital Medical School, London, and secretary of the Gilchrist Educational Trust, will begin on Thursday, May 7, when the first lecture will be given by Sir J. J. Thomson, O.M., master of Trinity College, Cambridge, on "The structure of light."

DR. GEORGE STUART FULLERTON, formerly professor of philosophy in the University of Pennsylvania and in Columbia University, died by suicide on March 23 at the age of sixty-six years. Professor Fullerton had been in ill health for some years, but had lectured at Vassar College. He was the author of books, monographs and articles on philosophy and psychology and had been president of the American Psychological Association.

MILTON H. FREEMAN, chief engineer of the New York and New Jersey Vehicular Tunnel, died at his home in Valhalla, N. Y., on March 24, aged fifty-four years, of acute pneumonia. Mr. Freeman succeeded Clifford M. Holland as chief engineer when the latter died on October 27 last.

N. H. COWDRY, known for his investigations dealing with the structure of plant cells, died on January 25, aged seventy-six years.

THE death is announced of Dr. John Cleland, F.R.S., emeritus professor of anatomy in the University of Glasgow, in his ninetieth year.

THE St. Andrews Institute for Clinical Research, Scotland, founded by the late Sir James Mackenzie, will henceforth be known as the James Mackenzie Institute for Clinical Research, in honor of the founder. An endowment of $300,000 is being raised to carry on the work of the institute.

THE city of Detroit, Mich., has been selected for the convention of the American Congress of Internal Medicine and of the American College of Physicians in 1926.

THE fifty-seventh annual meeting of the Kansas Academy of Science will be held at the Kansas State Agricultural College, Manhattan, Kans., on April 10, 11, 1925. The officers of the academy are: Professor H. H. Nininger, McPherson College, *president;* Dr. James E. Ackert, Kansas State Agricultural College, *first vice-president;* Professor F. U. G. Agrelius, Kansas State Teachers College of Emporia, *second vice-president;* Dr. L. D. Havenhill, University of Kansas, *treasurer,* and Professor E. A. White, University of Kansas, *secretary.*

ON March 13 and 14 a conference of Lake Superior geologists was held at the Department of Geology of the University of Wisconsin, at the invitation of Professor C. K. Leith, particularly to discuss problems of correlation in the Lake Superior region. In addition to the members of the department of geology, there were present at this conference geologists representing the Wisconsin Geological and Natural History Survey, the Minnesota Geological Survey, the Geological Survey of Canada and a number of the iron and copper mining companies in the Lake Superior region.

ON Saturday, April 11, in the Pacific Hotel, Spokane, Washington, members of Sigma Xi in the Northwest will meet at breakfast. The gathering is held in connection with the convention of the Northwestern Scientific Association, at which time also the Inland Empire Teachers' Association meets. The event is one of a number which Sigma Xi is making the endeavor to bring about in various sections of the country. It is a part of the idea which found expression in the New York gathering last November. It is hoped to spread the movement among Sigma Xi alumni so that at least once a year in various centers there will be a gathering of alumni members who are not connected with educational institutions.

THE University of Minnesota will be host this year to the Third Annual Colloid Symposium, which will be conducted at Minneapolis, on June 17, 18 and 19. The first and second symposiums on this increasingly important subject were at the University of Wisconsin and Northwestern University in 1923 and 1924. Professor Herbert Freundlich, of the Kaiser Wilhelm Institut, Berlin, a world authority on colloids, will be the principal guest lecturer. He will remain at Minnesota for the first summer session, to which his presence is expected to attract a distinguished body of chemists and physicists from many parts of the United States. The study of matter in the colloid state is now one of the closest links be-

tween abstract science and industry, as colloidal substances are all-important in such industries as the manufacture of rubber, the cereal industry, leather manufacture, paper making, the manufacture of plastics and the like. Dr. R. A. Gortner, head of the division of bio-chemistry, is in charge of arrangements. Assisting are Professors J. J. Willaman, L. H. Ryerson, G. B. Frankforter and others. Two years ago Professor The Svedberg, of the University of Upsala, was the guest lecturer, while last year Dr. Leonor Mischaelis, a German scholar now teaching in Japan, was the central figure.

A CHEMICAL EQUIPMENT EXPOSITION is to be held at Providence, R. I., from June 22 to 27, in connection with a meeting of the American Institute of Chemical Engineers. One day has been set aside to allow the members to visit the exposition. Among its unique features will be the arrangement on the program of various exhibits according to a flow sheet arrangement showing how each of the groups of equipment represented fits into the scheme of the unit processes of chemical manufacture.

A CONFERENCE of forty college teachers and executives and representatives of educational organizations met in Washington, on March 20 and 21, to discuss promotion of the research of teachers in American colleges, with a view to bringing college students, before they choose their life work, into contact with men actively engaged in research.

THE value of the Nobel prizes for 1925 will be 118,165 kroner or about $31,936, each. The original value of the prizes was 150,782 kroner.

THE *Journal* of the American Medical Association gives the following account of the award of the prizes of the French Academy of Medicine: The academy had forty-four prizes to distribute this year, the successful competitors nearly all being residents of Paris. The Audiffred prize, representing securities yielding 24,000 francs income, to be given "for a sovereign cure for tuberculosis," was not awarded, but prizes were given to Sicard and Forestier for their introduction of iodized oil into roentgenographic exploration; to Bourguignon, for his practical application of chronaxia; to Portret, for his success with galvanic electricity in treatment of exophthalmic goiter resistant to other measures, and to G. Ramon, of Garches, for his anatoxin for immunization against diphtheria. He found that diphtheria toxin loses its toxicity when incubated for several weeks, after addition of a little formaldehyde, while its antitoxin-producing power is intensified. Other prizes were given to G. Bidou, for success in helping cripples by his physiological control of artificial limbs, and to Hauduroy, for his discoveries on the behavior of the bacteriophage in typhoid. The academy offers fifty-three prizes for competition in 1925, all but six of which are open to the world. The academy has a total of eighty-eight prizes to distribute, and four new ones have been recently founded.

ACTION favorable to metric standardization of weights and measures was taken at the Pan-American Standardization Conference, which recently met in Lima, Peru. By resolution it was urged, "That the units of weights and measures in the various countries tend toward the decimal metric system." The United States of America, represented at the conference by an official delegation, is included in the recommendation. All the other American republics are already on the metric basis.

THE New York *Times* reports that the Malaria Commission of the League of Nations health organization met in Geneva, on March 23, under the chairmanship of Dr. Lutrario of Italy to draw up a program of investigation in Egypt, Palestine, Syria, Turkey, Sicily, Corsica and Spain. The investigation will be under way from May to September and will be a step in the international fight on malaria undertaken by the health organization of the league. A similar investigation has been made in Italy, the Balkans and in Russia. The session also will deal with the final report on the recommendations regarding malaria in Albania. Requests from the Turkish government for the appointment of experts to help to organize an anti-malaria campaign in Turkey and one from the French government to make a special inquiry in Corsica will be considered. A delegation to the first International Malaria Congress in Rome in October will be appointed, while a proposal to appoint additional members from the United States, India and France is to be considered. The commission also will discuss extensively the cheapest and most effective drugs to be used as well as the value of quinine and cinchona alkaloids in combating malaria. There also met, under the auspices of the League Health Board, Inspectors of Labor from ten countries, including the United States, for the first interchange of matters relating to industrial hygiene. After the conference shall have been finished the delegates will go to Belgium, France, Great Britain and Holland to study the methods of hygiene applied in those countries. On March 25, the general interchange of medical health officers which opened in England was continued in Geneva, when Dr. Norman White, *en route* home from Singapore after a study of epidemiological diseases, submitted his report.

UNIVERSITY AND EDUCATIONAL NOTES

JULIUS ROSENWALD, a member of the board of trustees of the University of Chicago, has given to the university a million dollars for the campaign fund of $17,500,000 for endowment, for research and for new buildings. At a recent meeting of alumni $500,000 was pledged to the fund.

THE will of the late Artemus Ward, after establishing a trust fund of a million dollars for his son and making various bequests, leaves the residue of his estate to Harvard University.

BY the death of Sir W. Northrup McMillan, formerly a citizen of St. Louis, Washington University will receive more than $1,000,000 for the establishment of a hospital to be known as the "McMillan Eye, Ear, Nose and Throat Hospital." Mr. McMillan's mother, who died in 1914, had provided that Washington University should receive the residue of her half interest in her husband's estate in the event that her son died without issue.

THE University of Michigan receives a fund of $375,000 from the estate of Silas Wright Dunning, who died on May 29 last at the age of eighty-five years. Mr. Dunning was for many years editor and chief owner of *The Railway Age*. The will directed that the fund be used to purchase books and periodicals for the university library.

THE *Journal* of the American Medical Association reports that the widow of Dr. Christian R. Holmes, for many years dean of the University of Cincinnati College of Medicine, had made a gift to the university of $25,000, in addition to the $250,000 previously given to endow the Christian R. Holmes deanship. This gift completes the pledges necessary to insure $700,000 from the General Education Board, and thus completes the $2,000,000 endowment for the College of Medicine, which was pledged in 1919.

DR. ALFRED H. LLOYD, professor of philosophy and dean of the graduate school of the University of Michigan, has been appointed acting president of the University of Michigan, to fill the vacancy caused by the death of President Marion E. Burton.

DR. HUGO MELLA, acting head of the department of neuropathology of the Harvard Medical School, has been appointed associate professor of neuropathology and psychiatry in the University of Colorado, Denver, and associate director of the Colorado Psychopathic Hospital.

J. B. BROWN, formerly research chemist with Swift and Company, Chicago, has accepted the position of assistant professor of physiological chemistry at the Ohio State University.

DISCUSSION AND CORRESPONDENCE

METHOD OF MEASURING DEEP SEA TIDES

IN the course of a conversation with William Beebe regarding plans for work to be done on his oceanic expedition, my attention was drawn to the fact that no method had been devised up to the present time for recording the rise and fall of the tides except in comparatively shallow waters. It appeared that the Hydrographic Office was very anxious to have data regarding the tides at localities where the depth of the ocean was measured in miles. The problem looked rather hopeless at first sight, but on thinking about it, the idea occurred to me that if we could make an artificial island, reaching up from the sea floor to within a few feet of the surface, the rest would be easy. Such an island could be made by means of a submerged buoy anchored to the sea bottom by a wire. If the ocean were calm, and there were no currents, this buoy would remain in a fixed vertical position above its cement anchor at a constant distance from the ocean floor. If the buoy contained a self-recording barograph of special design operated by the pressure of the water above the buoy, the periodic rise and fall of the tide would be recorded. Other factors might, and probably would, be present which would cause a variation in the height of the water above the buoy. Ocean currents, by causing the buoy to swing out from the vertical, would depress it, and there would of course be a rapid periodic change due to waves. It seems probable, however, that if the curve drawn on the revolving drum of the barograph was subjected to analysis by passing it through such a machine as Professor Michelson's harmonic analyzer, the tide curve would come out uncontaminated by the variations contributed in other ways. The scheme could be tried out at very small cost. The first experiments could be made in comparatively shallow water (say, three or four hundred feet), and the depth gradually increased. For deep sea work the position of the submerged buoy would have to be marked by a smaller surface buoy. The action of the wind on this would introduce another disturbing factor, which would disappear, however, in the analysis of the curve.

R. W. WOOD

JOHNS HOPKINS UNIVERSITY

OBSERVATIONS OF SHADOW BANDS

ON account of the snow which covered the ground on the day of the total eclipse of the sun of January 24, 1925, observations of shadow bands were made

by more people than ever before in the history of eclipses. Since the discussion of shadow bands is a meteorological problem rather than an astronomical one, the Committee on Eclipses of the American Astronomical Society has requested the cooperation of the chief of the U. S. Weather Bureau. This has been readily granted, with the result that the shadow band observations are to be discussed by Dr. W. J. Humphreys, meteorological physicist of the U. S. Weather Bureau, who is also a member of the eclipse committee.

A request is hereby made that observations of shadow bands be sent to the Chief of the U. S. Weather Bureau, Washington, D. C.

S. A. MITCHELL
Chairman of the Committee on Eclipses of the American Astronomical Society
UNIVERSITY OF VIRGINIA

THE SEGREGATION OF PHYSICAL GEOGRAPHY

WITHIN recent years there has been a tendency to segregate physical geography from the field of geography. There is voluminous literature available which emphasizes the position of physical geography as being geologic rather than geographic. In a few cases departments of earth sciences have reorganized since the wave of geographic interest with the result that physical geography is classified as a phase of geology.

Worthy reasons are undoubtedly responsible for these efforts and actions and it is not the intention of the writer to infer that they are not in part justifiable. The establishment of a department of geography separate from that of geology bears favorable comments, but the weaning of physical geography from geography, the mother of all sciences, is open to criticism.

The subject-matter of physical geography permits adaptation to both geography and geology. It may be referred to as a medium which merges into geography in one direction and into geology in the other direction. It is unquestionably the primary structure of the foundation of geography. Without its support geography is set adrift, which in many cases seems to be the state of affairs. The attempt to place greater emphasis on economics, history and political sciences as a substitute for physical geography has proven unsuccessful.

Every student of geography should be required to complete successfully either a separate course in physical geography or a fundamental course in geography in which emphasis is primarily placed on physical geography and climatology. These sciences serve with equal importance. If this statement is true, and it is accepted that there is no objection to climatology as a course in geography, why should there be a tendency to set physical geography aside? If it is essential to consider the cause and effect of atmospheric changes, why is it not equally important to consider the cause and effect of the changes of the earth's surface? This same lack of continuity in geography courses appears in comparing physical geography and economic geography if the former is not considered a phase of geography.

There seems to be but one solution and that is not to segregate physical geography but to accept it as a distinct part of geography.

F. A. CARLSON
OHIO STATE UNIVERSITY
DEPARTMENT OF GEOGRAPHY

MICROSPORIDIA[1]

IN a biological and taxonomic study of Microsporidia,[2] I recently included three genera and a family which had previously been established by Léger and Hesse[3] and which have recently been found to be invalid by Dr. T. D. A. Cockerell, of the University of Colorado, who kindly called my attention to the matter.

In the present note, I propose, according to the Article 34 of the International Rules of Zoological Nomenclature, renaming these three genera and one family of the Microsporidia.

Genus *Coccospora* nom. nov. for *Cocconema* Léger et Hesse (1921 : 1419), not *Cocconema* Ehrenberg, 1829, in Polygastrica.

Genus *Spirospora* nom. nov. for *Spironema* Léger et Hesse (1922 : 328), not *Spironema* Meeks 1864, in Mollusca nor *Spironema* Klebs 1892, in Protozoa, nor *Spironema* Vuillemin 1905, in Protozoa.

Genus *Toxospora* nom. nov. for *Toxonema* Léger et Hesse (1922 : 328), not *Toxonema* Boehm 1895, in Mollusca.

The change in the generic name necessitates a similar modification in the family name as follows:

Family *Coccosporidae* nom. nov. for *Cocconemidae* Léger et Hesse (1922).

ROKSABRO KUDO
ZOOLOGICAL LABORATORY
THE UNIVERSITY OF ILLINOIS

[1] Contributions from the Zoological Laboratory of the University of Illinois, No. 255.

[2] Kudo, R., 1924, "A biologic and taxonomic study of the Microsporidia." Illinois Biological Monographs, Vol. IX, pp. 83–268.

[3] Léger, L. et E. Hesse, 1921, Microsporidies à spores sphériques. C. R. acad. sci., t. 173, pp. 1419–1421. 1922, Microsporidies bactériformis et essai de systématique du groupe. *Ibid.*, t. 174, pp. 327–330.

IS OUR PLAN OF MEETINGS THE BEST POSSIBLE?

DURING the recent Washington meetings of the American Association for the Advancement of Science and Affiliated Societies I tried to satisfy my appetite by partaking of the scientific menus prepared. Eagerly I went from section to section to glean all I could, while the opportunity lasted, from the tables containing food. I thought I might eat without resulting indigestion. But after it was all over and I began to take stock of the whole banquet I was frankly disappointed. I was still hungry. And why?

I tried to analyze the situation and find out. After the hustle and excitement were all over and scientific tranquillity again prevailed in Washington, the following factors and resulting questions were considered as being closely related to the problem:

In several of the sections the programs were made up of a great many fragmentary papers unrelated to anything either preceding or following—models of isolation in majestic aloofness of any entangling alliances with other parts of the program. While five or ten minutes had been indicated as the time required for a paper, in numerous cases the enthusiastic exponent of the fragment of truth seemed utterly oblivious of the passage of time and the fact that he had made not only a probable but a palpable error in his calculations of two hundred or three hundred per cent. The great number of papers listed, therefore, looked formidable and prevented any material discussion of them to determine the exact relationship they bore to the world into which they had been momentarily exposed.

A surprisingly large number of these presentations were made by the younger generation of scientists, some of whom are just appearing on the horizon; and while the meetings were in session the older, wiser and more experienced members were often congregated in the halls enjoying the cordial contacts of friendship or exchanging views on matters of common interest. Their attitude seemed to be that they could later read the papers that are presented in the society's magazine, so why waste time in hearing them?

Now while it is recognized that one of the most important advantages to be gained from the meetings of the American Association for the Advancement of Science is the personal association with one's coworkers in science, may it not be possible to make the meetings so stimulating and interesting that more will desire to be present? Would it not be well to have the symposium idea more thoroughly developed and a much greater amount of interesting discussion engaged in? If the subjects for the symposium are carefully chosen from the standpoint of importance and current interest, the foundation should be laid for meetings of great benefit to those attending. In that event the menu might be so inviting that even the older members would be attracted to it and then give a really worth while "after-dinner speech."

It might be argued that this method would deprive many of the younger men of the opportunity of appearing on the program. But the door would still be open to them to contribute their viewpoint in the discussion or perhaps present some of the important symposium papers. Considering, however, the greatest good to the greatest number, would there not be distinct advantages to be gained by providing for fewer formal, fragmentary papers and for more time for thoroughly discussing in an informal way and from many angles some of the big aspects of research as applied to the outstanding problems with which the section for the time being is most concerned? I wonder if others may not have asked themselves the same question.

M. C. MERRILL

WASHINGTON, D. C.

EVOLUTION IN EDUCATION IN CALIFORNIA[1]

IN view of criticisms made before the State Board of Education regarding the presentation of the subject of evolution in certain text-books used in the high schools and junior colleges of this state, and of the board's desire that a careful review of this subject be made by qualified experts, the State Board on August 5, 1924, requested

> the presidents of the institutions in California accredited for high school certification as follows: University of California, Stanford University, Mills College, University of Southern California, Occidental College, Pomona College, University of Redlands, College of the Pacific and Dominican College to review these text-books and report to this board whether in their judgment there is in any of these text-books a presentation of the subject of evolution in such a way as to discredit the Bible and to develop in the minds of high school students an attitude of irreverence and atheism.

The president of the University of California was requested by the State Board of Education to serve as chairman of the committee of nine presidents.

The list of high school text-books of science submitted to the Committee of Nine, with page references to passages relating to evolution, is as follows:

[1] Report of Committee of College and University Presidents on the subject of evolution as treated in certain text-books used in high schools and junior colleges of California.

Bedford, *General Science*, p. 310 and following.
Hessler, *First Year of Science*, p. 258 and 312.
Elhuff, *General Science*, p. 305–334, 393, 407.
Gruenberg, *Elementary Biology*, p. 437, 274–335.
Hunter, *Civic Biology*, p. 191–196, 249, 404–406.
Moon, *Biology for Beginners*, p. 316–341.
Gager, *Fundamentals of Botany*, p. 502.
Jordan, Kellogg & Heath, *Animal Studies*, p. 417–448.
Linville & Kelly, *Text-book in General Zoology*, p. 99–115, 292, 434 to end of book.
Eddy, *General Physiology and Anatomy*, p. 38, 218, 219.
Norton, *Elements of Geology*, p. 291, 443 to end.
Young, *Lessons in Astronomy*, p. 348–358.

In response to the opportunity afforded by the Board of Education to all parties present at the hearing conducted by the board on August 4, 1924, and to all others interested, briefs on the subject of evolution, with special reference to the teaching of that subject in state-supported schools, were presented by

Rev. T. Hector Dodd, San Rafael.
Rev. Harry Gill, Sacramento.
Rev. Clarence Reed, Oakland.
Rev. George L. Thorpe, Corona.
Rev. E. E. Wall, Sacramento.

The members of the Committee of Nine have examined and considered those pages and sections of the twelve text-books to which their attention has been specifically directed, and likewise the five briefs. The committee respectfully submits the following report:

The theory of evolution, in one or another of its phases, is referred to in these books—it could scarcely be omitted from any text-book on biology, or astronomy, or geology—and in a few of the books some of the evidence in support of the theory of evolution is presented. In our opinion, these books have treated the subject with moderation and circumspection. There appear to be no statements derogatory to the Bible, and in the few instances in which the possible bearing of evolution upon religion is discussed at all, the writers have taken special pains to assure the readers that there is no conflict between science and religion. Evolution is presented as a theory, and not as an established fact, although it is stated here and there that the theory of evolution is commonly accepted by scientific men, and that is true. On this phase of the subject the following quotations have bearing:

A. Moon's Biology for Beginners, pp. 329–331: "Some Things that Evolution does *Not* Teach. . . . 'That man is descended from a monkey.' That God can be left out of the scheme of Creation. . . . While we can not go into the argument here, rest assured that in the minds of the greatest scientists and philosophers there is no conflict between the conclusions of Science and Religion. To quote Davenport, 'The Creator is still at work, and not only the forces of Nature, but man himself, works with God in still further improving the earth and the living things which it supports.'"

B. Gager's *Fundamentals of Botany*, pp. 516 and 517: "The publication of Darwin's *Origin of Species* aroused at once a storm of opposition. Theologians opposed the theory because they thought it eliminated God. . . . The unthinking and the careless thinkers accused Darwin of teaching that man is descended from monkeys. Neither of these accusations, however, was true. Darwinism neither eliminates God, nor does it teach that monkeys are the ancestors of men.

"By slow degrees, however, men began to give more careful and unprejudiced attention to the new theory, and not to pass adverse judgment upon it until they were sure they understood it. 'A celebrated author and divine has written to me,' says Darwin, 'that he has gradually learnt to see that it is just as noble a conception of the Deity to believe that He created a few original forms capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws.'"

The text-books before us are concerned with presenting scientific facts and theories of which every person with any pretense to an education in the subject or subjects treated should be informed. All departures of the authors from this simple policy may be said to show due respect and consideration for the fundamental principles of religion, as presented in the Bible.

(Signed) W. W. Campbell (Chairman)
President of the University of California
Ray Lyman Wilbur
President of Stanford University
Aurelia Henry Reinhardt
President of Mills College
Karl T. Waugh (acting for President R. B. von KleinSmid)
University of Southern California
Remsen D. Bird
President of Occidental College
James A. Blaisdell
President of Pomona College
V. L. Duke
President of University of Redlands
Tully C. Knoles
President College of the Pacific
Catherine O'Donnell
President of Dominican College

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE MEMBRANE MANOMETER

The introduction of a cannula into the carotid arteries of small animals like the rabbit, guinea pig and rat is at least for impracticed hands a matter of

considerable difficulty; and on account of the delicacy of the vessel wall, the small arterial pulsation and the ease with which clotting sets in, the results are often unsatisfactory. The abdominal aorta of these animals, however, is easily reached, its lumen is much larger, its walls are thicker and the pulsations are much larger, so that the use of this vessel is very satisfactory for the taking of routine blood pressure records by students.

The abdominal aorta is easily reached through a very long incision which is made in the abdominal wall as far to the left as possible and extending from the costal margin to the level of the pubis. A wide retractor made of a piece of tin, wide enough to fit in the incision and bent at right angles near the end, is used to retract the intestines as far as possible to the left. (Fig. 1.) This keeps the intestines entirely within the abdomen and preserves them from exposure, and at the same time it exposes the aorta.

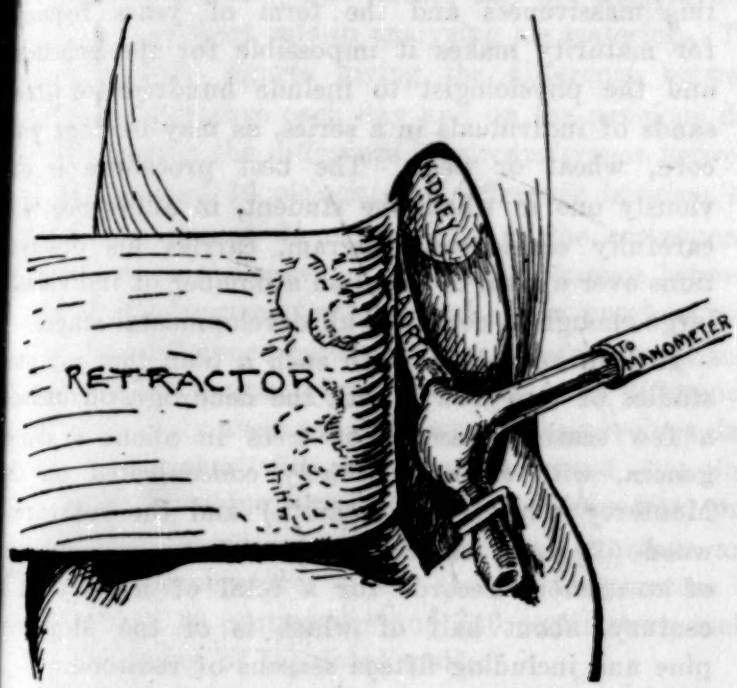

FIG. 1. Introduction of cannula into the abdominal aorta.

The aorta is dissected free as low as possible. The distal portion is ligated off above the bifurcation of the iliac arteries; the upper end is clamped off with a long-jawed bulldog clamp, a ligature is thrown around it and a bulbed T cannula is inserted into the aorta in the usual manner. The cannula is then filled with saturated Na_2CO_3, $MgSO_4$ or 5 per cent. sodium citrate solution and connected with a mercury manometer in the usual manner.

After this has been done the retractor is removed and the incision in the abdominal wall is held closed by a series of haemestats.

In this way large pulsations 2 to 3 mm in amplitude are easily obtained from the abdominal aorta of a rabbit and pulsations of 4 to 5 mm from the abdominal aorta of a cat. (Fig. 2.)

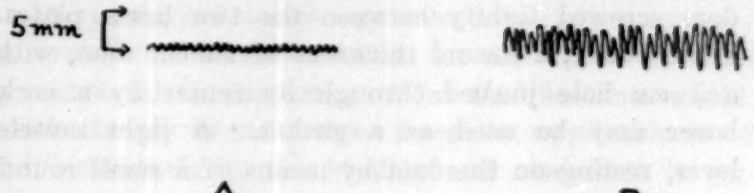

FIG. 2. Showing the records obtained with a mercury manometer from (A) the carotid artery and (B) the abdominal aorta of a cat.

The operation is easily carried out by students and well suited for class work.

Where large pulsations are desired for the study of the pulse rate and rhythm, as for study in the effect of digitalis on auricular fibrillation, we have made use of a modification of the Huerthle membrane manometer, which is very cheaply and easily constructed from materials which are at hand in any laboratory.

Two oblong pieces of brass plate are selected and near each of the four corners a hole to fit a small machine screw is drilled and threaded, so that the two plates can be screwed tightly together. (Fig. 3.) A hole one centimeter in diameter is drilled through the

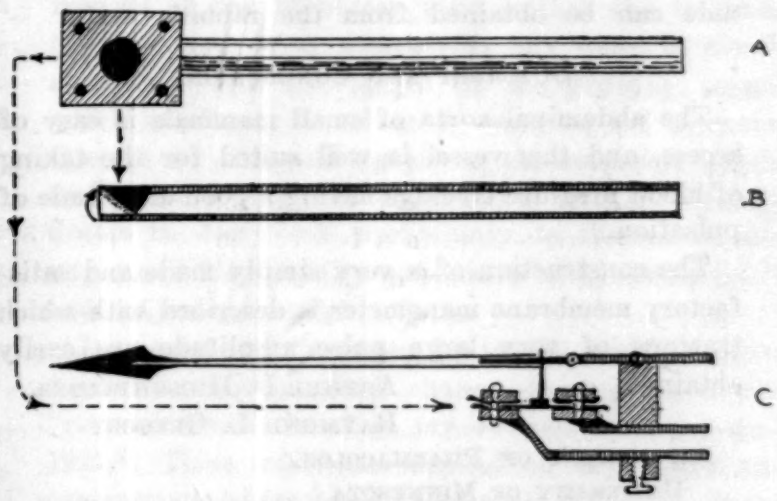

FIG. 3. Construction of a Simple Membrane Manometer.
A. View of manometer (exclusive of writing lever) from above.
B. Sagittal section of tube, showing lines for excision of the segment.
C. Lateral view of the completed apparatus.

center of the plate. The lumen of this hole forms the lumen of the tambour. The well of the tambour is completed by sawing a V-shaped wedge from near the end of a piece of 3/8 in. (10 mm.) brass tubing about 20 m long. The lip formed by the removal of the wedge is bent upwards to form a \— shaped end; and this is soldered to the lower surface of the lower plate in such a way that the beveled end

of the brass tubing forms the well of the tambour, while the long brass tube forms the shaft. The membrane is supplied by a piece of thin rubber dam screwed tightly between the two brass plates. If necessary, a second thickness of rubber dam, with a 1 cm hole pushed through its center by a cork borer may be used as a gasket. A light muscle lever, resting on the dam by means of a small round foot of sheet aluminum, transmits the pulsation to the lever. A light hollow straw bearing a writing tip of celluloid camera film furnishes the best lever.

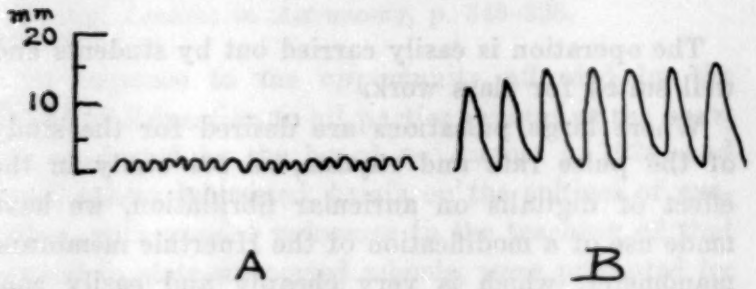

FIG. 4. Mercury manometer tracing (A) and membrane manometer tracing (B) from the abdominal aorta of a rabbit.

The tambour is filled with the anticoagulant solutions by means of a long capillary pipette, inserted through the shaft into the well of the tambour so as to drive out air bubbles.

With such a tambour pulsations 15 mm in amplitude can be obtained from the rabbit's aorta.

SUMMARY AND CONCLUSIONS

The abdominal aorta of small mammals is easy of access, and this vessel is well suited for the taking of blood pressure tracings having a good amplitude of pulsation.

The construction of a very simply made and satisfactory membrane manometer is described with which tracings of very large pulse amplitude are easily obtained.

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SPECIAL ARTICLES

TREE TRUNKS, GROWTH AND REVERSIBLE VARIATIONS IN CIRCUMFERENCE

THE forester bases his conclusions as to growth or production of lumber upon gross measurements compiled from hundreds of trees and is so impressed with individual differences, and with the varying effects of the seasons, that he has but little interest in the changes of the tree from day to day, or, in brief, with its behavior from a physiological viewpoint.

If the production of cellulose, etc., be considered as one of the main interests in forestry, it is obvious that methods similar to those used in the culture and growth of cotton, corn, wheat or flax may be expected to yield results as valuable to forestry as those obtained by making use of the technical results of experimental studies of these great staples.

The botanist, interested in trees as a type of vegetation in which photosynthesis, accumulation of nutritives, conduction of sap and translocation of material and transpiration are carried on in such manner as to afford unexcelled opportunities for study of fundamental problems, has begun to apply exact methods of measurement of the rate, seasonal course and amount of growth in trunks, and to identify the effects of temperature, soil-moisture and other features of the substratum, relative humidity, light intensity, length of season, age, developmental condition, defoliation and other injuries on the activity of growing points and cambial layers.

The size of a tree is an advantageous feature in experimentative manipulation. On the other hand this massiveness and the term of years requisite for maturity makes it impossible for the geneticist and the physiologist to include hundreds or thousands of individuals in a series, as may be done with corn, wheat or peas. The best procedure is obviously one in which the student, in adherence to a carefully considered program, carries his observations over a term of years on a number of individuals large enough to comprise all developmental stages.

It is in accordance with such a plan that my own studies of tree-growth with the dendrograph include a few seasons' records of trees in about a dozen genera, with attention chiefly concentrated on the Monterey pine (*Pinus radiata*) and the coast redwood (*Sequoia sempervirens*) with an accumulation of continuous records for a total of more than a century, about half of which is of the Monterey pine and including fifteen seasons of redwood.

Of the 29 Monterey pines under observation, the changes in the basal part of tree No. 1 have been recorded for six and one half years, a dendrograph has been attached to its trunk 27 feet from the base since January, 1920, and a similar record of a large root was begun in 1922.

Professor Hirokichi Nakashima has recently published the results of an attempt to find a mathematical expression for growth by a study of a five-year record of a single tree of *Abies Mayriana* in the Botanical Garden at Sapporo, Japan. A Friedrich's Zuwachsautograph was attached to a stem of this Japanese fir, which was about 24.98 mm in diameter at the beginning, and 25.68 mm at the close of the observations. Soil-temperatures and meteorological observations were made in the usual manner. The essential part of the growth-recorder

consists of a steel band, 80 centimeters long, with a temperature coefficient of 0.009 per degree C., which encircles the tree so that variations in circumference change the tension on a register lever.

The text and tables of Professor Nakashima's paper[1] amount to about two hundred pages and are illustrated with 26 plates. The summarized conclusions are to the effect that increase in the trunk results either from growth or swelling of the water-conducting tissues; variations in circumference depend closely on transpiration and absorption; increased transpiration without corresponding increase of water intake causes shrinkage; lessened transpiration is followed by swelling of the trunk. The climate of this locality includes a winter with low temperatures, snow and ice, and the year is divided into four periods with respect to the tree; that is, the rest period of winter, the spring transition period, the vegetation or growing period and the autumnal transition period. The author has not availed himself of any short cuts in analyzing his material. The data include figures giving the difference between the circumference each day and on the previous day at 7 o'clock; the difference in circumference between 7 o'clock and 14 o'clock; the difference between the circumference at 24 o'clock and at the corresponding time on the previous day; the difference between the circumference at sunrise and at the previous sunset; the difference between the circumference at sunset and the sunrise of the same day; the differences between daily averages and those of the previous day, which, together with figures as to wind direction, strength, sunshine, cloudiness, relative humidity, precipitation, evaporation, maximum and minimum and average temperatures of the air, the temperature of the soil at 30 centimeters and 120 centimeters, make up 155 pages of tabulated matter.

Precipitation, not the annual total, but the amount during the growing season, May to October, was found to be the determining factor in accretions to the basal part of the trunk, which is to be expressed by the formula, $y = a - b(x + 0.5)^c$, in which y = daily increase of circumference in mm, x = precipitation during the growing season in mm. By substitution, $y = 0.055 - 0.02785(x + 0.5)^{-0.41797}$.

Temperature was the determining factor in the changes of circumference of the trunk in the winter resting period, according to Professor Nakashima's conclusions. Y was taken to express amount of change, x the daily average temperature in the formula $y = a\,10^{-b(2-x)} - 0.2$. By substitution, $y = 0.66359.\,10^{-0.086265(2-x)} - 0.2$.

It is to be noted that these formulae include no physiological terms and recognize in no manner the result of stomatal action or the effect of storage material in the tree. What modifications would be necessary to make these formulae applicable to other individuals in the locality and elsewhere is yet to be seen.

A slight positive correlation between amounts of seasonal growth and rainfall was found by Dr. Shreve[2] in an examination of 125 trees of the Monterey pine, but a negative correlation between growth and rainfall during the season of activity. Advance of temperatures above a certain minimum starts the season's enlargement of the trunk, and reduction of the soil-moisture to something below 10 per cent. brings it to a standstill in mid-summer. It is notable, however, that the terminals begin to elongate earlier and continue to do so after wood-formation in the trunk has ceased, a matter to which G. A. Pearson has recently recalled attention.[3] It may be confidently predicted that the total growth of trees can not be profitably or correctly correlated with the march of any single environic component.

The only generalization as to the amount of growth that can be made upon the basis of the dendrographic records of the Monterey pine is that the thickness of the wood layer formed in any year is closely correlated with the length of the growing season, which obviously involves a complex of agencies. Growth in any case entails a condensation by dehydration of material to proteins and to carbohydrates in every cell preliminary to distention, and any curve fitted to this procedure will necessarily be wide of many available facts.

Increases and decreases in trunks which are not fixed by morphological change have been termed "reversible variations" in my own publications since 1921.[4] These variations depend on expansions and contractions of tracheids and vessels following altered tensions of the cohesive water-column present, and to a minor extent upon the state of hydration of the phloem and cortex. That these variations are not in the first instance an index of the balance between absorption and transpiration is shown by the fact that a contraction of the basal part of a giant redwood 150 feet in height ensues within 15 minutes after the rays of the rising sun strike the summit of the

[1] Nakashima, H., "Ueber den Einfluss auf den Stammumfang eines Tannenbaumes," *Journal* of the College of Agriculture, Hokkaido Imp. Univ., Sapporo. Vol. 12, part 2, May, 1924.

[2] MacDougal and Shreve, "Growth in trees and massive organs of plants," Publ. 350, Carnegie Institution of Washington, May, 1924.

[3] Pearson, G. A., "The growing season of the western yellow pine," *Jour. Agric. Research*, 29, 203, 1925.

[4] MacDougal, D. T., "Growth in trees," Publ. 307, Carnegie Institution of Washington, 1921.